

# STEM learning using PhET: A suite of free interactive simulations

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<http://phet.colorado.edu>

# Introductions & Goals

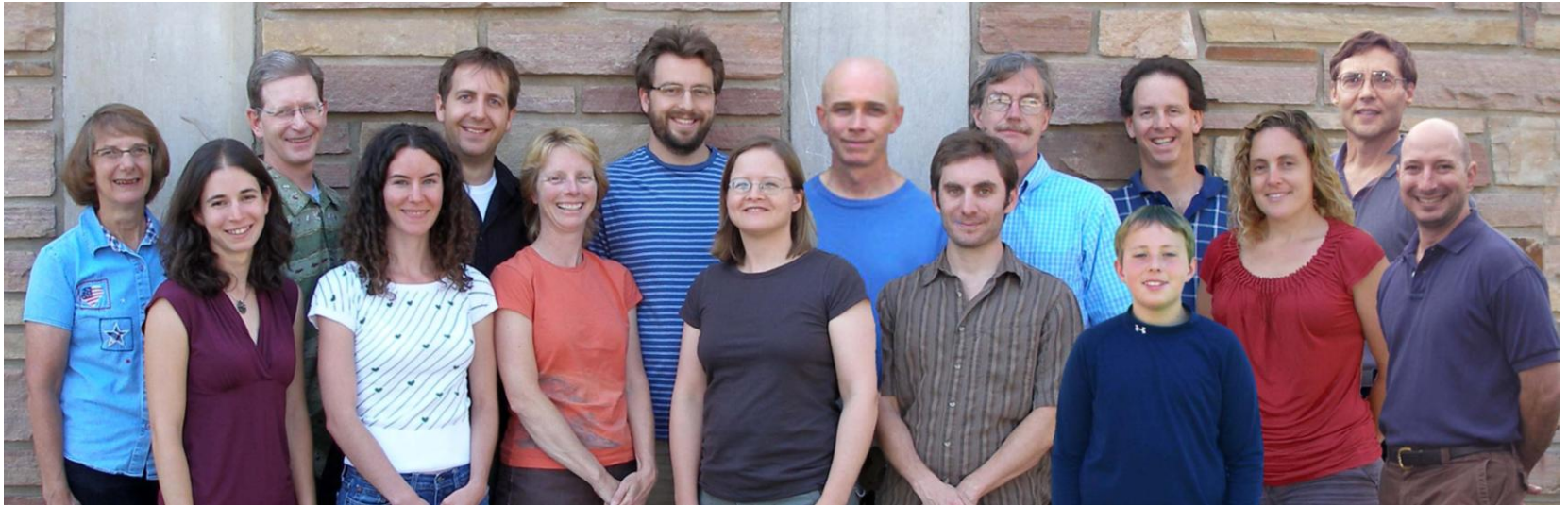
- Where are you from?
  - STEM teacher?
  - Administration/ed tech?
  - Teacher trainer?
- New to PhET?
- Used PhET sims in your class?
- What are your interests / goals today?

# Session Outline

1. Become familiar with PhET simulations
  - What are PhET sims and who makes them?
2. Sim design and research
  - How can PhET sims help students learn?
3. Explore the variety of uses for online learning environments

# Who are we?

University Faculty, Post-docs,  
K-12 Teachers, Computer Developers



What we do: Build and study new tools  
(simulations) and approaches for helping students  
and teachers improve science learning.

# PhET Funding



NSF

THE WILLIAM AND FLORA HEWLETT FOUNDATION

Hewlett Foundation

The O'Donnell Foundation



Collaborative agreement  
with King Saud University



University of Colorado



Carl Wieman and  
Sarah Gilbert



# PhET Interactive Simulations

- Suite of interactive simulations (>90)
- Physics , Chemistry , Math  
Expanding into biology, earth science
- Research-based and user-tested
- **Free!** Online or downloadable. (~130 MB)
- Easy to use and incorporate in class

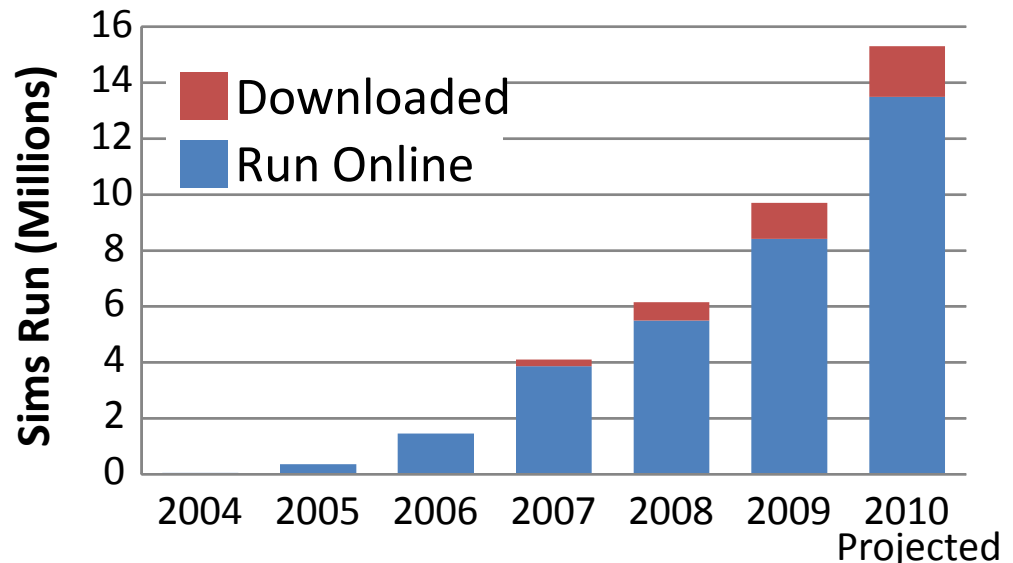
<http://phet.colorado.edu>



# Accessible


- Open-use License: Creative Commons – Attribution
- Easy to translate for World-wide Use:  
Over 1700 translations in 50 languages
- Over 15 million sims run per year, and growing

PhET sims run from website 2004-2010





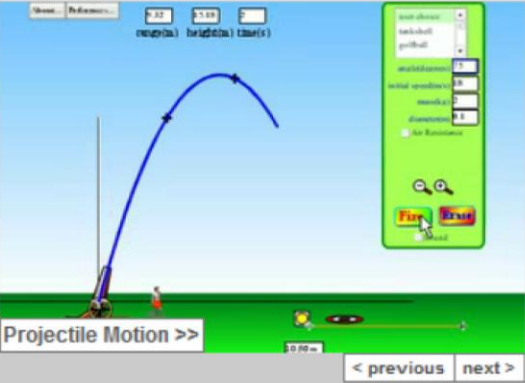
# Easy to use website



## Interactive Simulations

UNIVERSITY OF COLORADO AT BOULDER

Search




Projectile Motion >>

< previous next >


### Interactive Science Simulations

Fun, interactive, [research-based](#) simulations of physical phenomena from the PhET project at the University of Colorado.


[Play with sims... >](#)



ECSME at King  
Saud University



National Science  
Foundation



THE WILLIAM AND FLORA  
HEWLETT FOUNDATION

The William and Flora  
Hewlett Foundation

► How to Run Simulations	► For Teachers	► Contribute	► About
<ul style="list-style-type: none"><li>► On Line</li><li>► Full Installation</li><li>► One at a Time</li></ul>	<ul style="list-style-type: none"><li>► Activities contributed by Teachers</li><li>► Workshops</li></ul>	<ul style="list-style-type: none"><li>► Provide ideas you've used in class</li><li>► Support PhET</li><li>► Translate simulations</li></ul>	<ul style="list-style-type: none"><li>► What's New?</li><li>► About PhET</li><li>► Contact Us</li><li>► Sponsors</li></ul>

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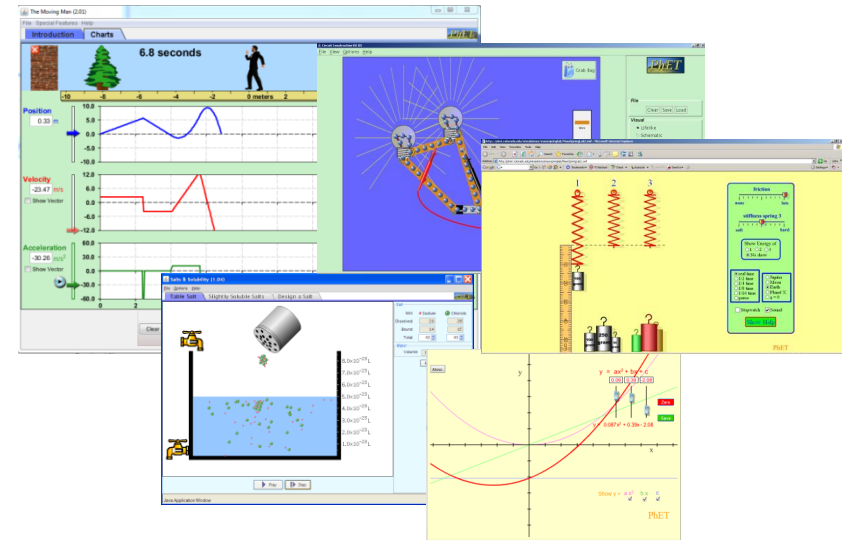


# Thoughts or reflections about the design?

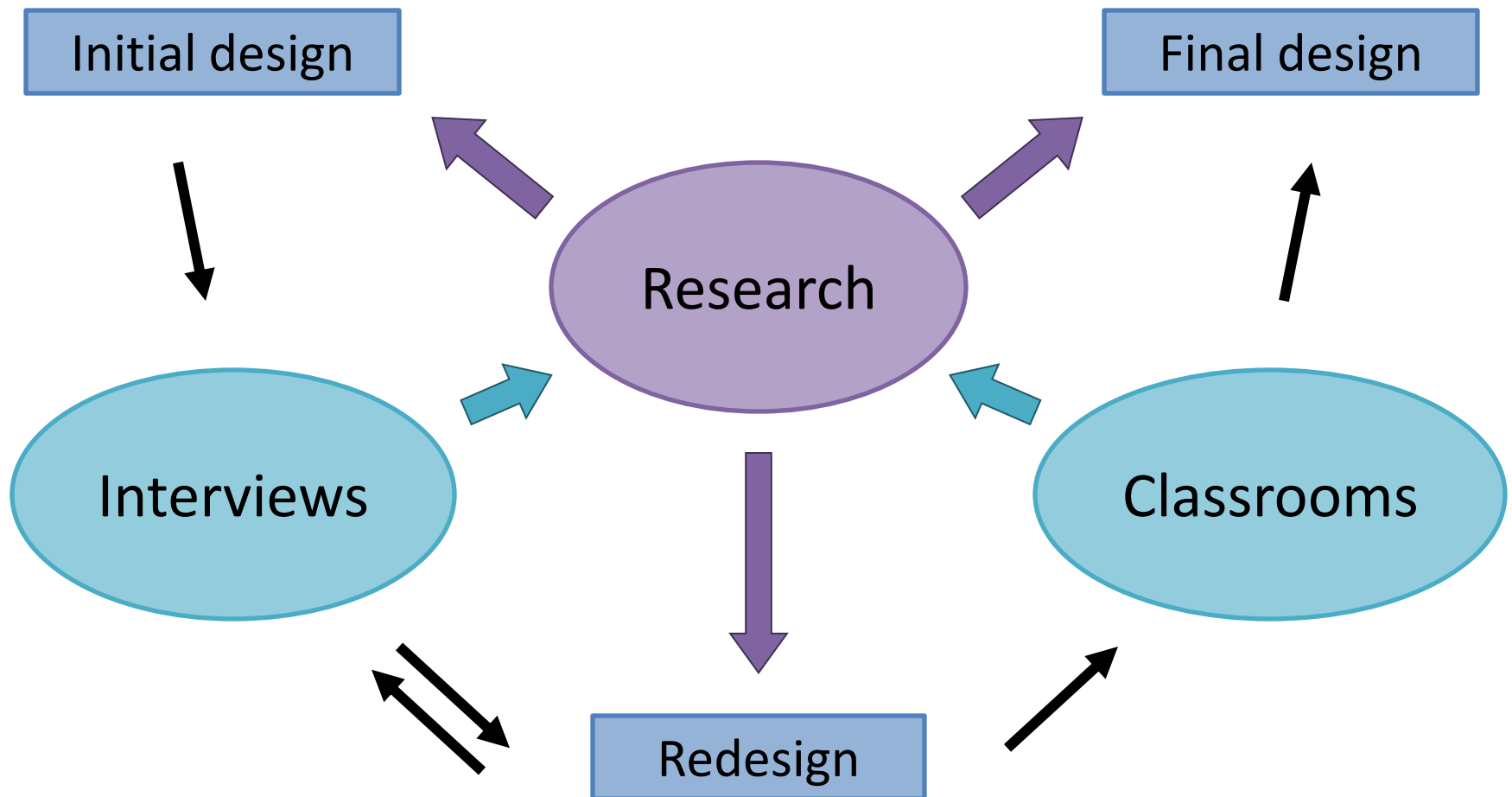
## Why use sims?

Your thoughts here:

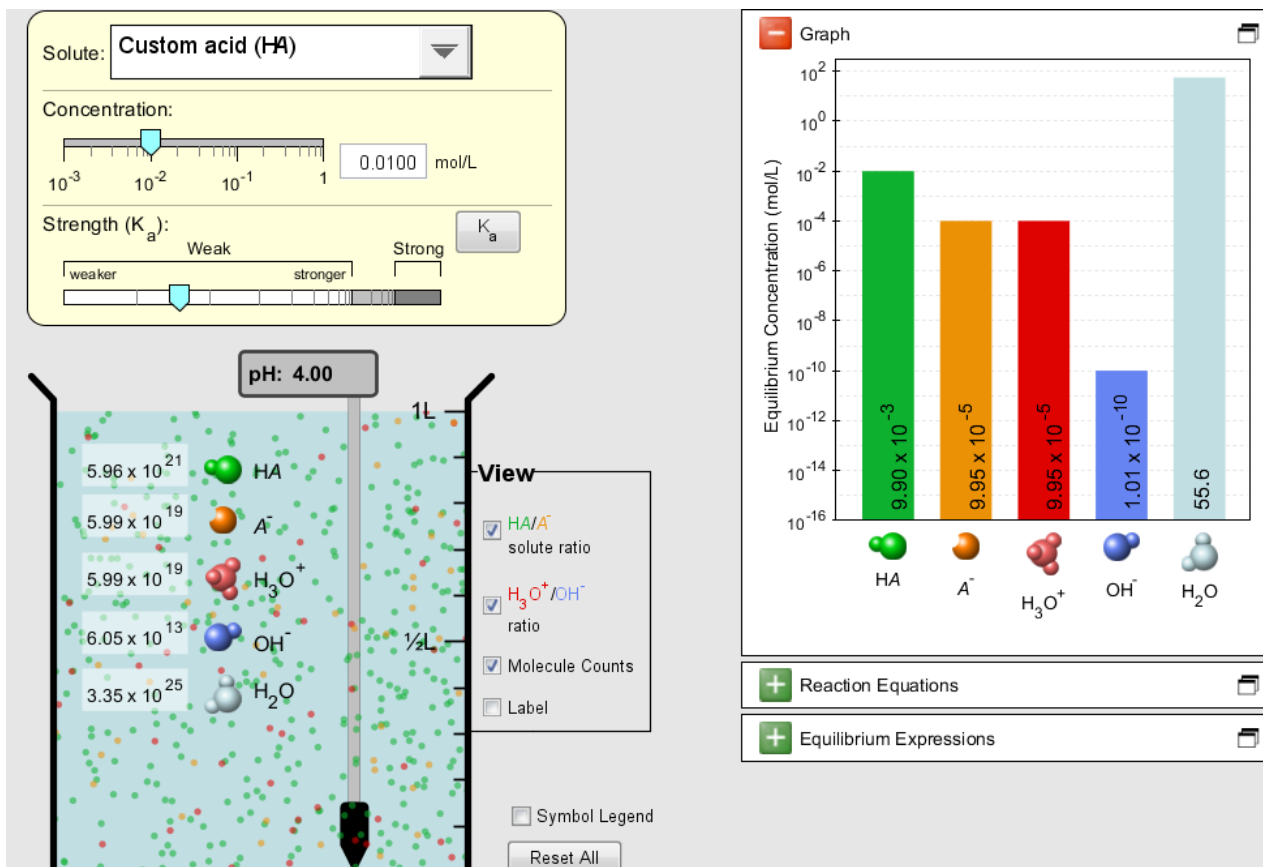
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# PhET Design Process



# Old Acid-Base Solutions



# New Acid-Base Solutions

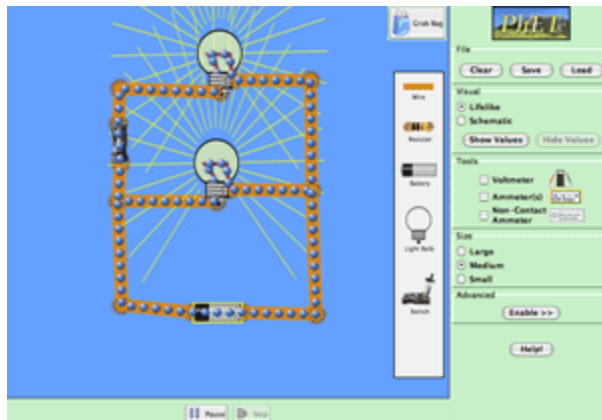
The screenshot shows the PHET Acid-Base Solutions (1.00) simulation window. The interface includes a menu bar with 'File' and 'Help', and tabs for 'Introduction' and 'Custom Solution'. A 'pH Color Key' at the top left shows a color gradient from red (pH 0) to blue (pH 14). The main area displays a beaker of light blue liquid with a magnifying glass focusing on the molecular view. A vertical pH scale on the right indicates a pH of approximately 1. The right sidebar contains three sections: 'Solutions' with radio buttons for Water (H<sub>2</sub>O), Strong Acid (HA), Weak Acid (HA), Strong Base (MOH), and Weak Base (B); 'Views' with radio buttons for Molecules, Equilibrium Concentration, and Liquid, and a checkbox for Show Solvent; and 'Tests' with radio buttons for pH Meter, pH Paper, and Conductivity. A 'Reset All' button is at the bottom of the sidebar. At the bottom of the main area, a chemical equation is shown:  $\text{HA} + \text{H}_2\text{O} \rightarrow \text{A}^- + \text{H}_3\text{O}^+$ , with corresponding molecular models for each species.

*Why is this sim better?*

# Made for easy use

- Flexibility for you to
  - ✓ Pick and choose which sims to use
  - ✓ Customize use ...  
to your environment and your learning goal
  - ✓ Search database of activities (by PhET or Teacher-users)

## Circuit Construction Kit



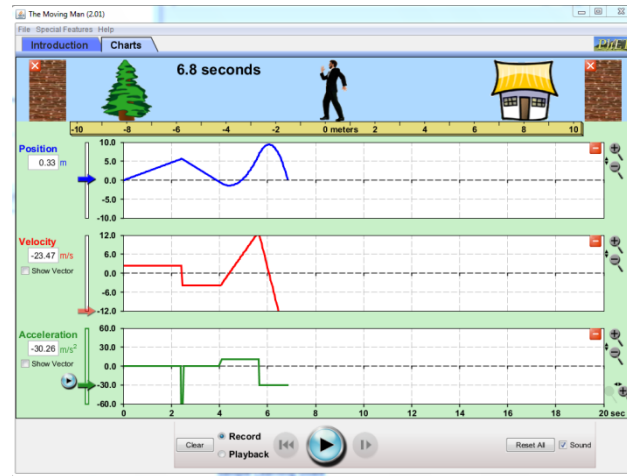
## CCK in grade school:

“Make the light bulb light”

## CCK in college:

“Explain why the light dims when you turn the heater on”

# Ideas for Using Sims?

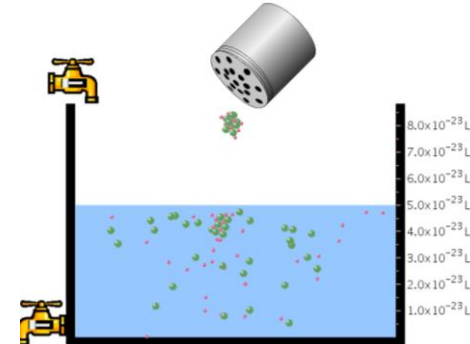


- How could you use these sims in your class?
- Do they help you address learning goals that are otherwise hard to address?

GO TO ACTIVITIES DATABASE

# Designing Activities:

## What will students learn in each activity?



Add 100 silver bromide pairs to the water. How many silver and bromide ions dissolve in the water? Repeat this for all salts.

Investigate different salts. What features do salts have in common, and how do salts differ from each other?

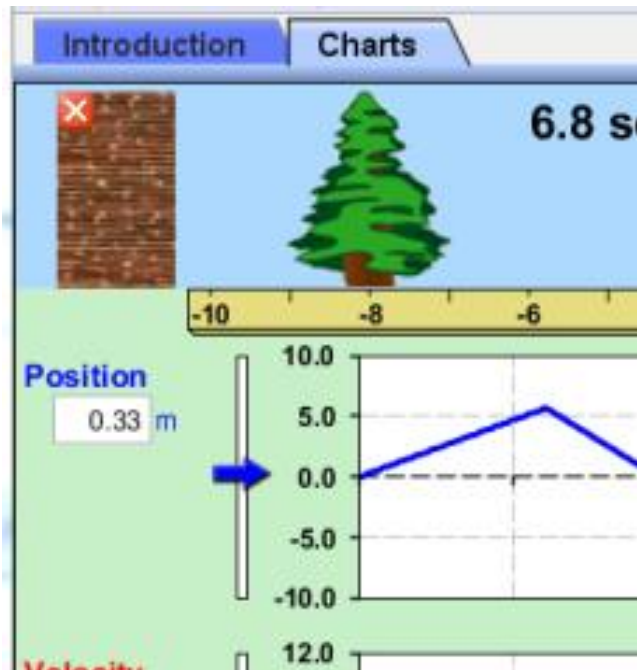
*What will students be doing in each activity?*

*What will students learn in each activity?*



# Implicit Scaffolding & Activity Design

- ❖ Implicit scaffolding to support productive exploration
  - ✓ Choice of Controls. Productive Constraints
  - ✓ Dynamic feedback linking interaction and animation.
  - ✓ Explicit visual & conceptual models (that experts use)



The screenshot shows a chemistry simulation interface. At the top, there is a legend for particles: electrons (blue dots), protons (red dots), and neutrons (grey dots). Below the legend, there is a large circular area representing an atom. In the center, there is a nucleus labeled "Lithium" containing three protons and three neutrons. Two electrons are shown in orbit around the nucleus. To the right of the atom, there is a red label "+ Ion". Below the atom, there are three bowls labeled "Protons", "Neutrons", and "Electrons" containing red, grey, and blue spheres respectively. On the right side, there is a periodic table of elements. Below the periodic table, there are three panels: "Symbol" showing "6 Li" with a "+1" charge, "Mass" showing "6", and "Charge" showing "+1". At the bottom right, there is a "Reset All" button and a checkbox labeled "Show Labels".

# Use of PhET sims in class

## Lecture/classroom

Visual Aid, Demo complement,  
Interactive Lecture Demos, & Concept tests

## Lab and Recitation

Group activity, Exploration and discovery

## Homework

Pre-class assignment – introduce new ideas  
Post instruction – develop robust understanding

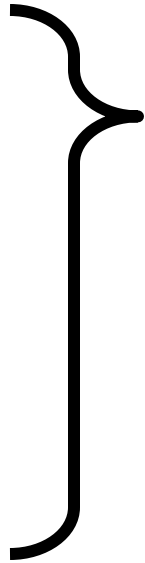


# Use of PhET sims

Lecture/classroom

Lab and Recitation

Homework



Opportunity for  
student scientist-like  
exploration

But, no silver bullet:  
**Context and Activity  
critical**

# Stay in touch

Submit an activity to our database for teachers

Send us your ideas for new sims

New ways to stay connected:

PhET Blog

Facebook

Twitter

Email:

[phethelp@colorado.edu](mailto:phethelp@colorado.edu)

